CONTINUATION OF SURFACE WATER QUALITY MONITORING TO SUPPORT THE IMPLEMENTATION OF THE LAMPASAS RIVER WATERSHED PROTECTION PLAN

Final Report
TSSWCB Project # 19-54
Prepared by Texas A&M AgriLife Research

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Acronyms

AgriLife Research	Texas A&M AgriLife Research
BRA	Brazos River Authority
BMP	Best Management Practice
CFS	Cubic feet per second
cfu/100mL	colony forming units per 100 milliliters.
CRP	Clean Rivers Program
DSLP	Days since last precipitation
FM	Farm to Market
HWY	Highway
mg/L	milligram per liter
Partnership	Lampasas River Watershed Partnership
QAPP	Quality Assurance Project Plan
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TIAER	Texas Institute of Applied Environmental Research
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TSSWCB	Texas State Soil and Water Conservation Board
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plans

Introduction

The Lampasas River watershed lies within the Brazos River Basin in Central Texas (Figure 1), which drains to the Gulf of Mexico. The Lampasas River's headwaters are in eastern Mills County and it flows southeast for 75 miles, passing through Hamilton, Lampasas, Burnet and Bell counties. In Bell County the river turns northeast and is dammed five miles southwest of Belton to form Stillhouse Hollow Lake. Stillhouse Hollow Lake is the primary drinking water supply for much of the surrounding area. Although the watershed encompasses 798,375 acres across Mills, Hamilton, Coryell, Lampasas, Burnet, Bell, and Williamson Counties, it is primarily a rural watershed with few urban centers. The cities of Lampasas and Kempner are wholly within the watershed boundaries, while the cities of Copperas Cove and Killeen are only partially in the watershed.

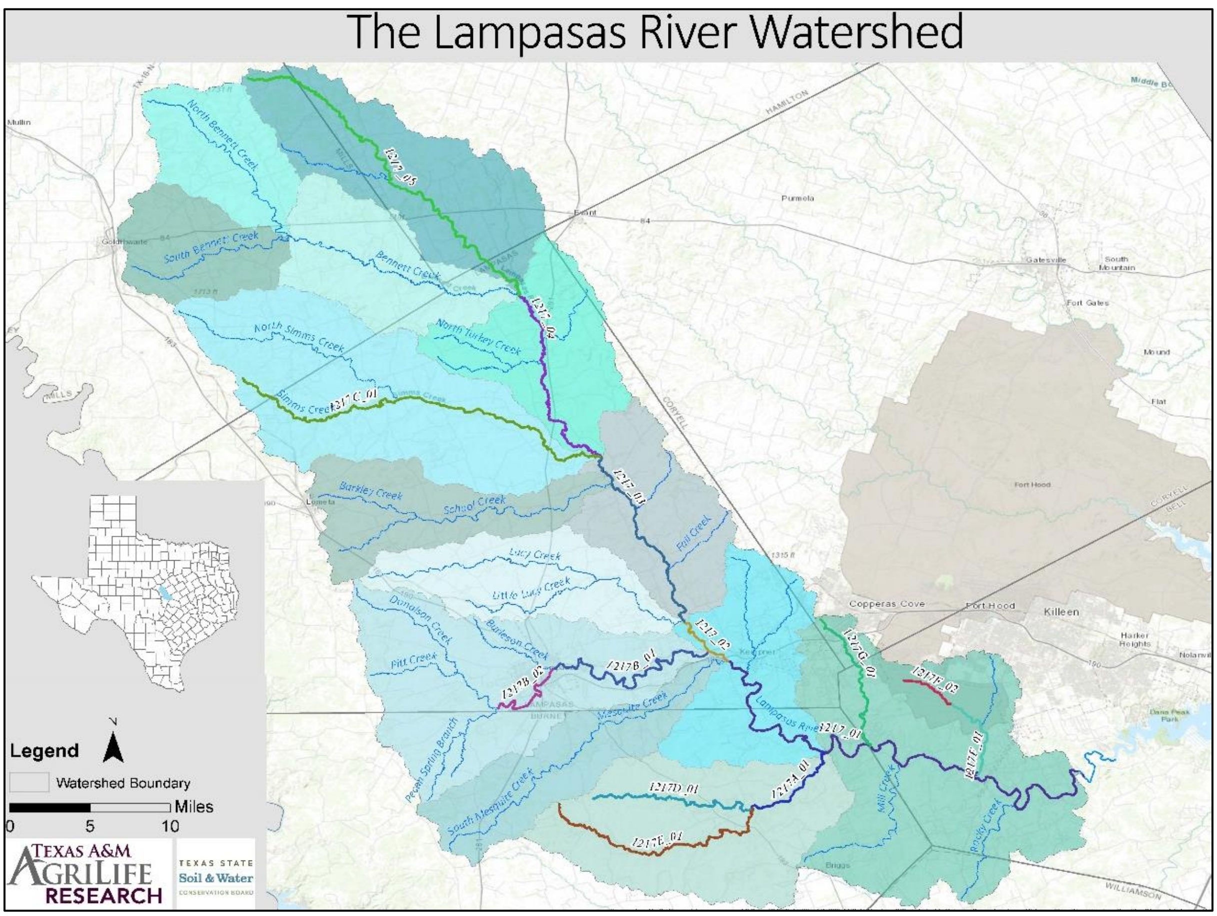


Figure 1 The Lampasas River watershed is a primarily rural watershed, located in Central Texas in the Brazos River basin.

The Lampasas River was originally listed on the 2002 303(d) List for elevated levels of bacteria and carried forward to subsequent lists in 2004, 2006 and 2008. Elevated bacteria levels are an indicator of fecal contamination from warm blooded animals and is a human health hazard. Texas A&M AgriLife Research (AgriLife Research) and Texas State Soil and Water Conservation Board (TSSWCB) established the Lampasas River Watershed Partnership (Partnership) in November 2009 as part of TSSWCB project 07-11, *"Lampasas River Watershed Assessment and Protection Project"*. The project included an updated land use analysis, modeling of historical water quality data, and the development of a Watershed Protection Plan (WPP) to address the bacteria impairment.

The development of the WPP was a stakeholder driven process facilitated by AgriLife Research. With technical assistance from AgriLife Research and other state and federal partners, the Steering Committee identified water quality issues that are of particular importance to the surrounding communities. The Steering Committee also contributed information on land uses and activities that were utilized in identifying the potential sources of bacterial impairments and in guiding the development of the WPP. The WPP identified responsible parties, implementation milestones, and estimated financial costs for individual management measures and outreach and education activities. The plan also described the estimated load reductions expected from full implementation of all management measures. To provide an accurate measure of the effectiveness of the WPP, the Partnership recommended an intensive water quality monitoring regime within the river and its tributaries.

Subsequent projects in the watershed have continued the implementation of the WPP, including TSSWCB project 12-09*, "Coordinating Implementation of the Lampasas River Watershed Protection Plan"*, and TSSWCB projects 14-07 and 17-05 focused on coordinating the implementation of the WPP while, TSSWCB projects 14-06 and 17-03 provided resources at the local level to Hill Country Soil and Water Conservation District to support a watershed-wide District Technician to facilitate the development of Water Quality Management Plans (WQMPs) and implementation of nonpoint source best management practices (BMP) with local landowners. AgriLife Research has also cooperated with Texas Commission on Environmental

Quality (TCEQ) to begin addressing potential failing on-site sewage systems through several projects.

It is important to note that the Lampasas River was removed from the 2010 303(d) list. The delisting of the river occurred because additional data had not been collected for assessment between 2000 and 2009; existing historical data no longer met the TCEQ criteria to be included in assessment. North Rocky Creek (Segment 1217D) was identified as impaired for depressed dissolved oxygen in 2006, however a TCEQ study conducted in 2009 showed high aquatic life. Biological data collected from North Fork Rocky Creek indicates that it supports a relatively healthy biological community, better than that which would be expected based upon the results of the dissolved oxygen monitoring. In 2010, the TCEQ adopted revised, site-specific standards for dissolved oxygen in Rocky Creek which then received EPA approval. Although the site specific standards had been approved for the segment, a minimum of ten additional data points was necessary to assess against the new standards. TSSWCB Project 16-06 collected five of those data points.

Over the years, other tributaries have been placed on and removed from the Integrated Reports as concerns based on screening levels. A portion of Sulphur Creek (Assessment Unit (AU) 1217B_02) had a screening level concern for depressed dissolved oxygen, while Clear Creek (AU 1217G_01) had a screening level concern for nitrate in 2014 Integrated Report. The 2016 Integrated Report also included a new listing for Sulphur Creek (Segment 1217B_02) for not meeting the state contact recreation standard. The most recent Integrated Report (2020) carries forward the depressed dissolved oxygen impairment for North Fork Rocky Creek as the only impairment in the watershed. However, there were several segments with concerns for use attainment and screening levels. Assessment unit 1217_05 (portion of Lampasas River from confluence with Bennett Creek upstream to its headwaters in Mills County) has a concern for near-nonattainment of the TSWQS based on numeric criteria (CN) for bacteria in the water and a concern for water quality based on screening levels (CS) for Chlorophyll-a in water. Assessment unit 1217B_02 (from the spring source located in the City of Lampasas upstream to the confluences with Bean Creek and East Fork Sulphur Creek west of Lampasas in Lampasas County) has a CS for depressed dissolved oxygen in water.

Project Overview

AgriLife Research coordinated with Texas Institute of Applied Environmental Research (TIAER) to implement the recommended water quality monitoring regime which was outlined in the WPP. Historically surface water quality data was collected by the Brazos River Authority (BRA) and TCEQ through the Clean Rivers Program (CRP) on a quarterly basis.

The sampling sites were selected by the Partnership for long term sampling (Figure 2). The Partnership deemed these ten sites as "critical" for evaluating the effects of implementation. These sites were identified because they will yield a dataset that is all encompassing of areas where implementation will be focused and is spatially representative of the watershed. They felt that uninterrupted, routine, monthly monitoring would be key to providing accurate data to reflect changes within the watershed.

TIAER conducted routine ambient monitoring at ten sites monthly collecting field, conventional, flow, and bacteria parameter groups. TIAER collected monthly routine flow samples over a period of 14 months, from October 2019 through November 2020. Spatial and seasonal variations were captured across the sampling period (Table 1). The sites included 5 mainstem sites and 5 sites across 3 tributaries.

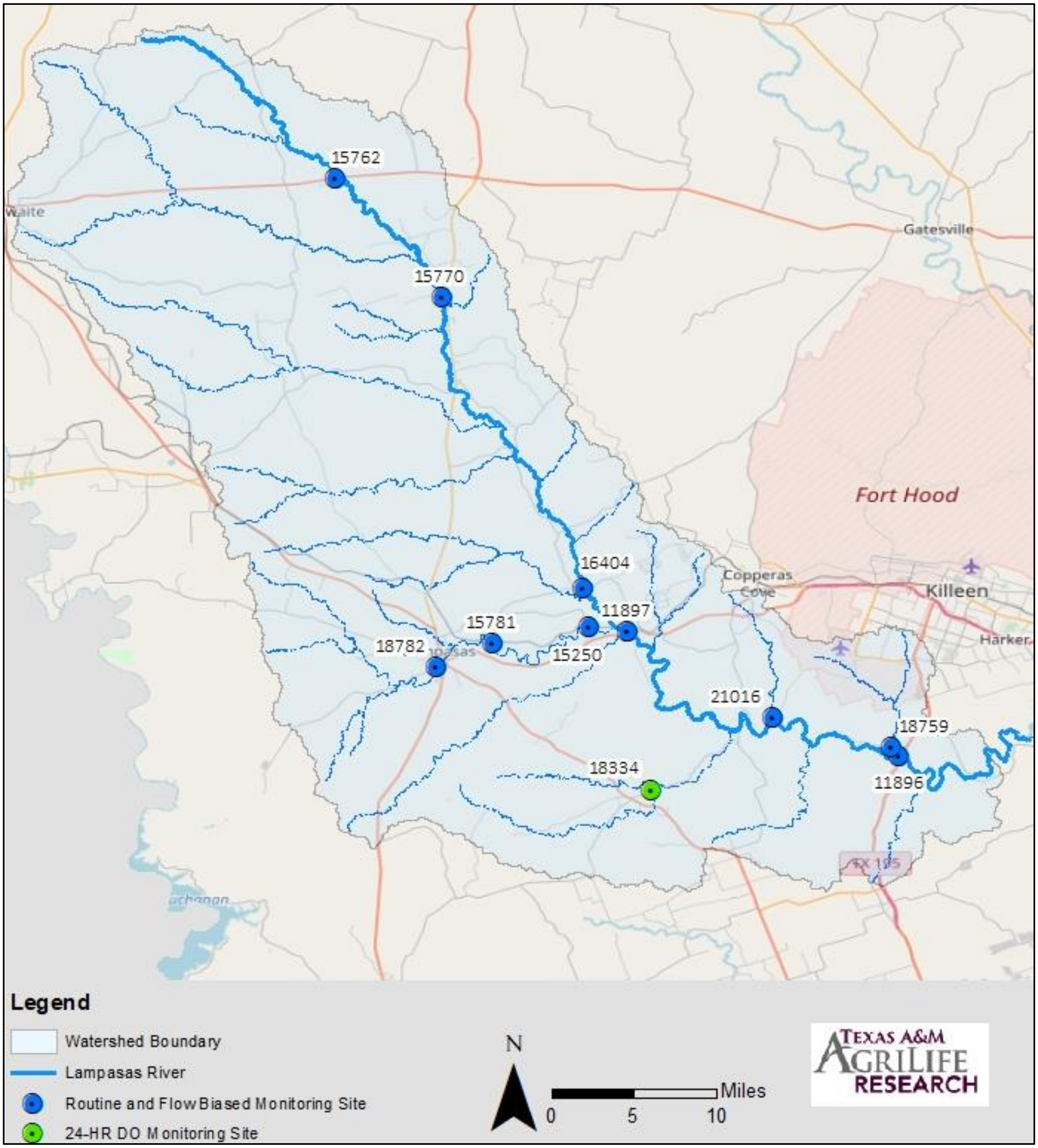


Figure 2 Ten monitoring sites were selected within the Lampasas River watershed for routine and biased flow monitoring. Station 18334 was added in 2018 to collect 24-hr dissolved oxygen samples.

TIAER also conducted biased flow monitoring at the 10 sites once per quarter/season under wet weather conditions, collecting field, conventional, flow, and bacteria parameter groups. If a routine sampling event happened to capture wet weather conditions, an additional wet weather sample was not collected that quarter.

In addition to sampling efforts at the 10 mainstream and tributary sites, the workplan included the collection of five 24-hr DO samples at station 18334, North Fork Rocky Creek at FM 963. This was collected to provide the necessary data for the segment to be assessed with the TCEQ approved revised site-specific standards.

Table 1 Samples were collected at 10 sites during routine and storm flow conditions over a 14-month period, in addition to 24-hr DO samples at station 18334.

TCEQ Station ID	Station Description	Monitoring Type		Total
		RT	RTBA	
15762	Lampasas River at US 84	13	3	16
15770	Lampasas River at Lampasas CR 2925	13	3	16
16404	Lampasas River at FM 2313	13	3	16
11897	Lampasas River at US 190	13	3	16
11896	Lampasas River at HWY 195	13	3	16
18782	Sulphur Creek at Naruna Rd	13	3	16
15781	Sulphur Creek at Lampasas CR 3010	13	3	16
15250	Sulphur Creek at Lampasas CR 3050*	13	3	16
18759	Reese Creek at FM 2670	13	3	16
21016	Clear Creek at Oakalla Rd	13	3	16
18334	North Fork Rocky Creek at FM 963	5	NA	5

* The roadway name for Station 15250 changed from CR 8 to CR 3050 and the SWQM description has changed to reflect that. The QAPP utilizes the CR 8 description, but it will be referred to as CR 3050 throughout this report.

Project Highlights

Data Collection and Submittal

Data collected through this project was collected under an approved Quality Assurance Project Plan (QAPP) that was reviewed in September 2020 and updated to reflect the current project timeline. The objective of the quality assurance task was to develop and implement data quality objectives and quality assurance/control activities to ensure data of known and acceptable quality are generated through this project. The QAPP was recertified in September 2020 by project staff to ensure it accurately reflected the data collection and handling.

Highlights and Evaluation of Water Quality Monitoring Data

TIAER conducted routine ambient monitoring at 10 sites monthly, collecting field, conventional, flow, and bacteria parameter groups. The objective of the routine monitoring was to provide sound water quality data to more accurately assess the status of the Lampasas River by enhancing current routine ambient monitoring regimes. Analyzing this water quality data can show trends and the effectiveness of a WPP. TIAER and AgriLife Research coordinated with other entities, TCEQ and BRA, to avoid overlapping of resources, which allowed those agencies to focus their limited resources in other waterbodies. TIAER's laboratory also conducted the sample analysis. Field parameters were pH, temperature, conductivity, and dissolved oxygen. Conventional parameters were total suspended solids, turbidity, nitrate + nitrite nitrogen, Total Kjeldahl Nitrogen (TKN), chlorophyll-a, pheophytin, and total phosphorus (TP). Flow parameters were collected by electric, mechanical, or Doppler, including severity. Bacteria parameter is E. *coli*. A full list of parameters and field codes can be found in Table 2.

Table 2 Measurement performance specifications of parameters collected.

PARAMETER	UNITS	MATRIX	METHOD	PARA-METER CODE	AWRL	LOQ	LOQ CHECK STD %Rec	PRECISION (RPD of LCS/LCS dup)	BIAS (%Rec. of LCS)	Lab
Field Parameters										
pH	pH/ units	water	SM 4500-H^+ B. and TCEQ SOP, V1	00400	NA	NA	NA	NA	NA	Field
DO	mg/L	water	SM 4500-O G. and TCEQ SOP, V1	00300	NA	NA	NA	NA	NA	Field
Specific Conductance	µS/cm	water	SM 2510 and TCEQ SOP, V1	00094	NA	NA	NA	NA	NA	Field
Temperature	ºC	water	SM 2550 and TCEQ SOP, V1	00010	NA	NA	NA	NA	NA	Field
Flow	cfs	water	TCEQ SOP, V1	00061	NA	NA	NA	NA	NA	Field
Days since precipitation event	days	water	TCEQ SOP V1	72053	NA	NA	NA	NA	NA	Field
Flow measurement method	1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler	water	TCEQ SOP, V1	89835	NA	NA	NA	NA	NA	Field
Flow severity	1-no flow 2-low 3-normal 4-flood 5-high 6-dry	water	TCEQ SOP, V1	01351	NA	NA	NA	NA	NA	Field
Flow Estimate	cfs	water	TCEQ SOP, V1	74069	NA	NA	NA	NA	NA	Field
Maximum pool width at time of study[1]	meters	other	TCEQ IGD	89864	NA	NA	NA	NA	NA	Field
Maximum pool depth at time of study[1]	meters	other	TCEQ IGD	89865	NA	NA	NA	NA	NA	Field
Pool length[1]	meters	other	TCEQ IGD	89869	NA	NA	NA	NA	NA	Field
% pool coverage in 500-meter reach[1]	meters	other	TCEQ IGD	89870	NA	NA	NA	NA	NA	Field
Conventional and Bacteriological Parameters										
TSS	mg/L	water	SM 2540 - D	00530	4	4	NA	NA	NA	TIAER
Chlorophyll-a, spectrophotometric method	µg/L	water	SM 10200 - H	32211	3	3	NA	NA	NA	TIAER

Pheophytin, spectrophotometric method	µg/L	water	SM 10200 - H	32218	3	3	NA	NA	NA	TIAER
E. *coli*, modified mTEC	CFU/100mL	water	EPA 1603[2]	31648	1	1	NA	0.5[3]	NA	TIAER
Total Kjeldahl Nitrogen	mg/L	water	SM 4500 – NH_3 G	00625	0.2	0.2	70-130	20	80-120	TIAER
Nitrate+Nitrite-N, total	mg/L	water	SM 4500 – NO_3 F	00630	0.05	0.05	70-130	20	80-120	TIAER
Total Phosphorus	mg/L	water	EPA 365.4	00665	0.06	0.06	70-130	20	80-120	TIAER

Data Summaries

Routine and Storm Samples

Beginning October 17, 2019 through November 10, 2020, monthly routine sampling events were conducted. During the first 5 months of sampling, site 15762, the most upstream sites, was routinely pooled, or dry. During that same period, 5 routine events had pools insufficient to collect samples from. Additionally, although storm samples were collected at all other sites on February 12, 2020, site 15762 remained insignificantly pooled to collect a sample. From March through July, all sites were flowing or had pools significant enough to collect samples from. During the routine sampling event on August 11, 2020, site 15762 was not flowing and had an insignificant pool and therefore not sampled. During the same sampling event, site 15770 was not flowing, but did have a significant pool, so a sample was collected.

The 3 remaining mainstem sites had routine flow, as did the 5 tributary sites during the sampling period.

Dissolved Oxygen Events

TIAER collected 24-hr DO measurements at station 18334 during five events over the project period. The 24-hr monitoring was done in conjunction with routine monthly monitoring, spaced throughout the year and allowing at least a month separation between 24-hr events. Two samples were collected in the Non-Index Period (January – March 14 and October 16 – December), while three were collected during the Index Period (March 15 – October 15). Of the three collected during the Index Period, two were collected during the Critical Period (July 1 – October 15).

Data Deficiencies

The pheophytin result for sample TX97397, collected from station 16404 on April 13, 2020, was excessively negative. The TIAER Laboratory Manager investigated the situation and could find no specific cause for the failure. Laboratory staff monitored chlorophyll-a and pheophytin results for three months for additional cases of excessively negative results. The lack of pheophytin data was noted in the Comments column of the Event file for the sample.

After the routine sampling event on July 14, 2020, the refrigerator used to hold chlorophyll-a aliquots malfunctioned. The ten project aliquots collected were in the refrigerator during this time. The temperature reached a maximum of 6.7ºC, which exceeds the analysis maximum of 6.0 ºC. Consequently, the chlorophyll-a data for samples TX97422 – TX97431 are not included in the Results file and is noted in the Comments field of the Event file.

Samples collected for analysis of total phosphorus, TKN, and total nitrate-plus-nitrite is collected from the waterbody in an acidified container which must have a pH of 2.0 or less. The pH measured by the TIAER Laboratory at login of sample TX97434, collected at station 18759 on August 11, 2020 was greater than 4.0, which exceeds the maximum. Consequently, the sample lacks data for these three analytes in the Results file.

After the routine sampling event in September 2020, the refrigerator used to house the total phosphorus and total Kjeldahl nitrogen aliquots for project samples TX97453 – TX97462 malfunctioned while the samples were inside. The temperature exceeded 6.0°C, which is the maximum allowable temperature. Consequently, total phosphorus and total Kjeldahl nitrogen data for the samples are not included in the Results file. The omission is noted in the Comments field of the Event file. TIAER purchased a new refrigerator to prevent this from happening again in the future.

Data Tables

The following data tables compile the data collected to date at the five mainstream and five tributary sites. Table 3 compares the geometric mean of the E. *coli* data collected at each site during dry to normal conditions to the geometric mean of the data collected under high flow conditions. All five tributary sites (18782, 15781, 15250, 21016 and 18729) had geomeans well within the state's standards for Contact Recreation 1 during routine monitoring events as did the three most downstream sites on the mainstem of the Lampasas River (16404, 11897, 11896).

Table 3 Concentrations of E. *coli* during routine and biased flow conditions at all sites.

TCEQ Station Description	Monitoring Type															
	Routine Mainstem or Tributary Sample						Biased flow Sample						Total			
	Flow		E. coli				Flow		E. coli				Flow		E. coli	
	N	Mean	N	Geo-mean	Min	Max	N	Mean	N	Geo-mean	Min	Max	N	Mean	Geo-mean	E. coli % Change
Lampasas River at US 84*	13	28	7	237	120	600	3	3	2	53	28	102	16	24	170	663%
Lampasas River at CR 2925	13	6	13	107	24	890	3	28	3	356	82	920	16	10	134	2,641%
Lampasas River at FM 2313	13	198	13	60	7	12,000	3	829	3	5,451	3,000	12,000	16	316	140	41,834%
Lampasas River at US 190	13	12	13	26	5	94	3	107	3	1,041	57	4,600	16	30	52	7,906%
Lampasas River at HWY 195	13	265	13	92	9	18,000	3	752	3	8,580	4,700	14,000	16	356	216	65,902%
Sulphur Creek at Naruna Rd	13	9	13	40	5	156	3	4	3	378	120	2,400	16	8	61	2,805%
Sulphur Creek at Lampasas CR 3010	13	18	13	40	24	79	3	15	2	1,520	420	5,500	16	18	65	11,591%
Sulphur Creek at CR 3050	13	34	13	38	10	1,700	3	34	3	5,831	1,300	61,000	16	34	98	44,753%
Reese Creek at FM 2670	13	6	13	60	22	112	3	13	3	889	71	5,200	16	7	100	6,735%
Clear Creek at Oakalla Rd	13	2	13	27	2	340	3	27	3	960	43	10,300	16	7	53	7,288%

[1]Number of samples collected.

[2]Percent change in pollutant between wet and dry flows. Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration

Table 4 shows the mean of the concentrations of total phosphorus (TP) at the routine sites. Although at no time or under any flow conditions did the mean exceed the screening concentration of 0.69 milligrams per liter, there was a significant increase in total phosphorus during wet weather conditions at all but 1 site, Clear Creek at Oakalla Rd., which showed a decrease in high flow.

Table 4 Concentrations of Total Phosphorus during routine and biased flow conditions at all sites.

TCEQ Station Description	Monitoring Type													
	Routine Mainstem or Tributary Sample					Biased flow Sample					Total			
	Flow (cfs)		TP (mg/L)			Flow (cfs)		TP (mg/L)			Flow (cfs)		TP (mg/L)	
	[1]N	Mean	Min	Max	Mean	N	Mean	Min	Max	Mean	N	Mean	Mean	[2]TP % Change
Lampasas River at US 84	13	28	0.071	0.106	0.089	3	3	0.082	0.082	0.082	16	24	0.088	-8%
Lampasas River at Lampasas CR 2925	13	6	0.030	0.142	0.087	3	28	0.064	0.076	0.070	16	10	0.084	-20%
Lampasas River at FM 2313	13	12	0.030	0.163	0.099	3	107	0.030	0.326	0.145	16	30	0.108	46%
Lampasas River at US 190	13	198	0.030	0.131	0.082	3	829	0.030	0.123	0.077	16	316	0.081	-6%
Lampasas River at HWY 195	13	265	0.030	0.086	0.047	3	752	0.098	0.178	0.138	16	356	0.066	191%
Sulphur Creek at Naruna Rd	13	9	0.030	0.588	0.139	3	4	0.104	0.132	0.114	16	8	0.134	-18%
Sulphur Creek at Lampasas CR 3010	13	18	0.074	0.307	0.146	3	15	0.160	0.265	0.213	16	18	0.155	45%
Sulphur Creek at CR 3050	13	34	0.030	0.160	0.086	3	34	0.146	0.184	0.165	16	34	0.099	92%
Clear Creek at Oakalla Rd	13	2	0.092	1.081	0.306	3	27	0.129	0.252	0.187	16	7	0.284	-39%
Reese Creek at FM 2670	13	6	0.030	0.213	0.091	3	13	0.030	0.142	0.102	16	7	0.093	13%

[1]Number of samples collected.

[2]Percent change in pollutant between wet and dry flows. Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration

Table 5 is the mean of the concentrations of Total Kjeldahl Nitrogen at the routine sites. There was a decrease during high flow conditions at all sites.

Table 5 Concentrations of Total Kjeldahl Nitrogen (TKN) under low to normal and high flow conditions at all monitoring sites.

TCEQ Station Description	Monitoring Type													
	Routine Mainstem or Tributary Sample					Biased flow Sample					Total			
	Flow (cfs)		TKN (mg/L)			Flow (cfs)		TKN (mg/L)			Flow (cfs)		TKN (mg/L)	
	[1]N	Mean	Min	Max	Mean	N	Mean	Min	Max	Mean	N	Mean	Mean	[2]TP % Change
Lampasas River at US 84	13	28	0.071	0.106	0.089	3	3	0.082	0.082	0.082	16	24	0.088	-8%
Lampasas River at Lampasas CR 2925	13	6	0.030	0.142	0.087	3	28	0.064	0.076	0.070	16	10	0.084	-20%
Lampasas River at FM 2313	13	12	0.030	0.163	0.099	3	107	0.030	0.326	0.145	16	30	0.108	46%
Lampasas River at US 190	13	198	0.030	0.131	0.082	3	829	0.030	0.123	0.077	16	316	0.081	-6%
Lampasas River at HWY 195	13	265	0.030	0.086	0.047	3	752	0.098	0.178	0.138	16	356	0.066	191%
Sulphur Creek at Naruna Rd	13	9	0.030	0.588	0.139	3	4	0.104	0.132	0.114	16	8	0.134	-18%
Sulphur Creek at Lampasas CR 3010	13	18	0.074	0.307	0.146	3	15	0.160	0.265	0.213	16	18	0.155	45%
Sulphur Creek at CR 3050	13	34	0.030	0.160	0.086	3	34	0.146	0.184	0.165	16	34	0.099	92%
Clear Creek at Oakalla Rd	13	2	0.092	1.081	0.306	3	27	0.129	0.252	0.187	16	7	0.284	-39%
Reese Creek at FM 2670	13	6	0.030	0.213	0.091	3	13	0.030	0.142	0.102	16	7	0.093	13%

[1]Number of samples collected.

[2]Percent change in pollutant between wet and dry flows. Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration

Lampasas River Mainstem Stations

15762: Lampasas River at US 84

The Lampasas River at US Hwy 84 monitoring site (station 15762, **Error! Reference source not found.** and Figure 5) is located in the northern portion of the watershed in western Hamilton County and is the most upstream sampling location. The upstream drainage area is primarily rangeland and is approximately 56 square miles. From November 2019 thru February 2020, no samples were collected due to insufficient pool size per TCEQ SWQM standards. Out of 13 routine samples collected during the project period, 3 were collected in pools and 6 events collected no samples due to insufficient pool size. In addition, 1 biased flow sample was not collected due to an insignificant pool as well.

15770: Lampasas River at CR 2925

The Lampasas River at Lampasas County Rd 2925 monitoring station (station 15770, **Error! Reference source not found.** and Figure 7) is located in northern Lampasas County approximately 2.5 miles downstream of the Bennett Creek confluence. The upstream drainage area is primarily rangeland and is 279 square miles. Like the station upstream, flows at this site were typically low during the summer and early fall months. However, the stream was flowing for all 13 routine sample collections, except for the sample collected on August 11, 2020.

16404: Lampasas River at FM 2313

The Lampasas River at FM 2313 monitoring station (station 16404, Figure 8 and Figure 9) is located in southern Lampasas County approximately 2.8 miles upstream of the Sulphur Creek confluence. The upstream drainage area is primarily rangeland and encompasses 614 square miles. Due to the larger drainage area, this station was flowing during collection of all 13 routine sampling events.

11897: Lampasas River at US 190

The Lampasas River at US HWY 190 monitoring station (station 11897, Figure 10 and Figure 11) is located in southern Lampasas County approximately 0.8 miles downstream of its confluence with Sulphur Creek. The upstream drainage area is primarily rangeland although its summer flows are heavily influenced by Sulphur Creek, which includes the city of Lampasas. The total upstream drainage area for this site is 816 square miles.

11896: Lampasas River at HWY 195

The Lampasas River at State HWY monitoring station (station 11896, Figure 12 and Figure 13) is located in eastern Bell County, approximately 7 miles upstream of its confluence with Stillhouse Hollow Lake. The upstream drainage area is primarily rangeland, but the area also includes drainage from tributaries that encompass the Cities of Lampasas, Kempner, Copperas Cove, and Killeen. This is the most downstream station for the Lampasas River. The total drainage area for this station is 1,195 square miles. This site was flowing for all 13 routine sampling events for this project.


Figure 4 Station 15762, Lampasas River at US 84, looking upstream from sampling location on October 13, 2020.


Figure 5 Station 15762, Lampasas River at US 84, looking downstream from sampling location on October 13, 2020.

Figure 6 Station 15770, Lampasas River at Lampasas CR 2925, looking upstream from sampling location on October 13, 2020.

Figure 7 Station 15770, Lampasas River at Lampasas CR 2925, looking downstream from sampling location on October 13, 2020.

Figure 8 Station 16404, Lampasas River at Lampasas FM 2313, looking upstream from sampling location on October 13, 2020.

Figure 9 Station 16404, Lampasas River at Lampasas FM 2313, looking downstream from sampling location on October 13, 2020.

Figure 10 Station 11897, Lampasas River at US 190, looking upstream from sampling location on October 13, 2020.

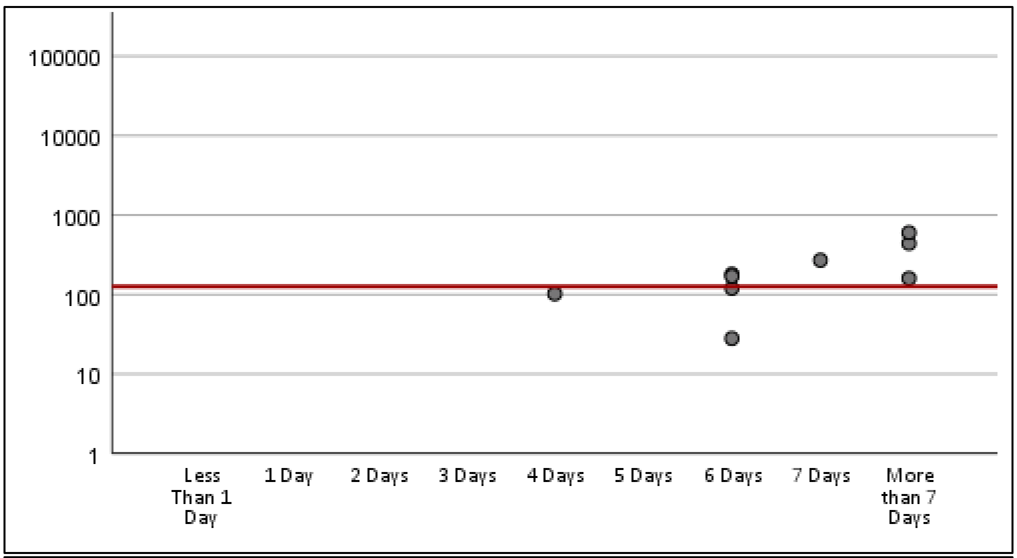
Figure 11 Station 11897, Lampasas River at US 190, looking downstream from sampling location on October 13, 2020.

Figure 12 Station 11896, Lampasas River at HWY 195, looking upstream from sampling location on October 13, 2020.

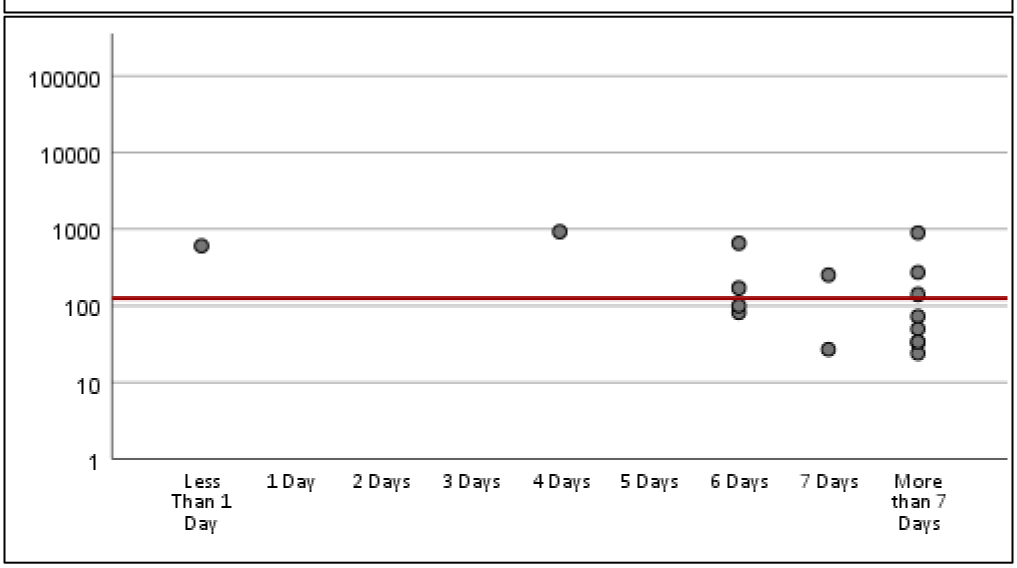
Figure 13 Station 11896, Lampasas River at HWY 195, looking downstream from sampling location on October 13, 2020.

Analysis of Lampasas River Mainstem Data for Trends

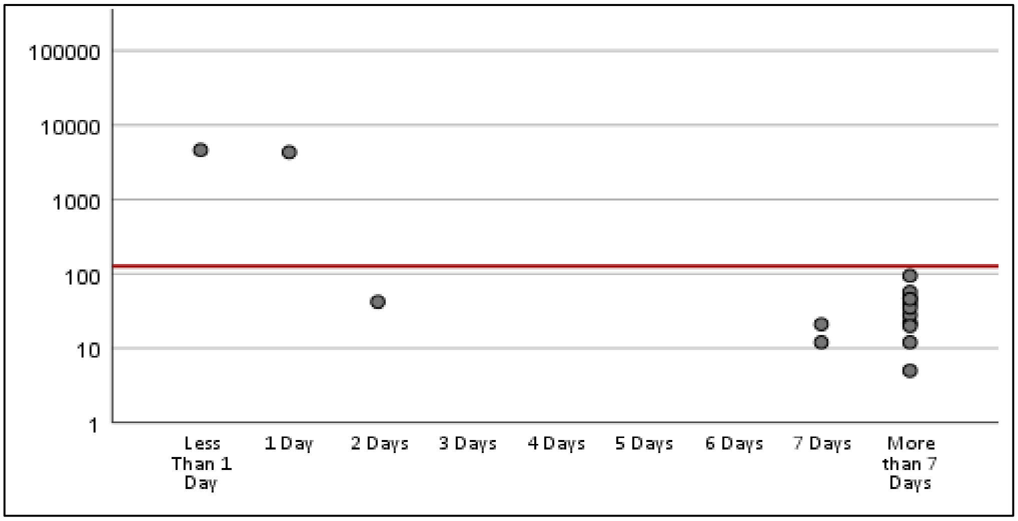
Although a 13-month sampling period is not temporally robust enough for most statistical analysis, it is interesting to look at the relationship between E. *coli* and the Days Since Last Precipitation (DSLP) parameters. The following figures (A-E) illustrate the (log of) E. *coli* sample collected plotted on the X axis against the number of days since last precipitation on the Y axis. The red line illustrates the state standard of 126 cfu/100mL). As you move downstream, the number of samples that exceed 126 cfu/100mL during drier periods (more than 7 days since last precipitation) decreases. This may indicate that as baseflow increases, the E. *coli* concentration decreases. This same trend was seen while analyzing the data collected during the previous project as well.



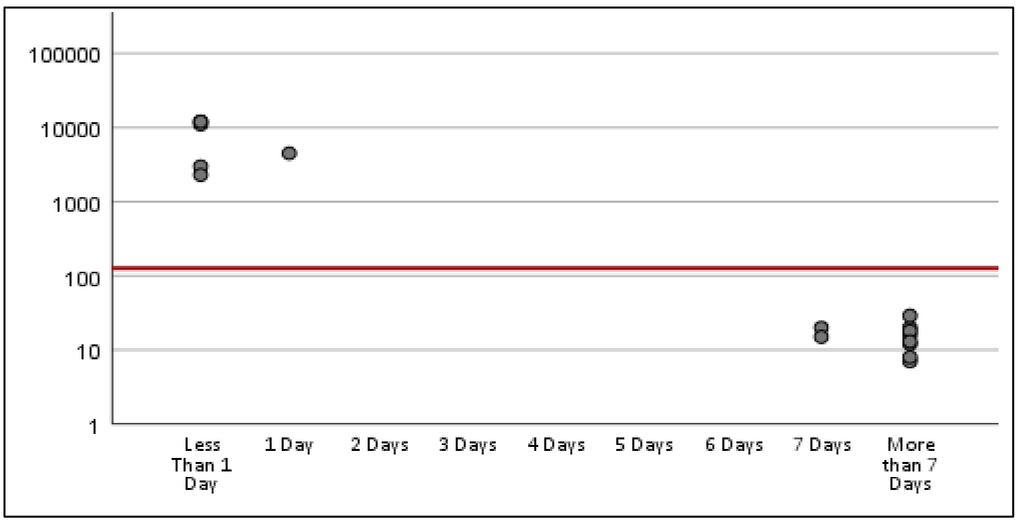
(A)
Lampasas River
at US 84
Station 15762



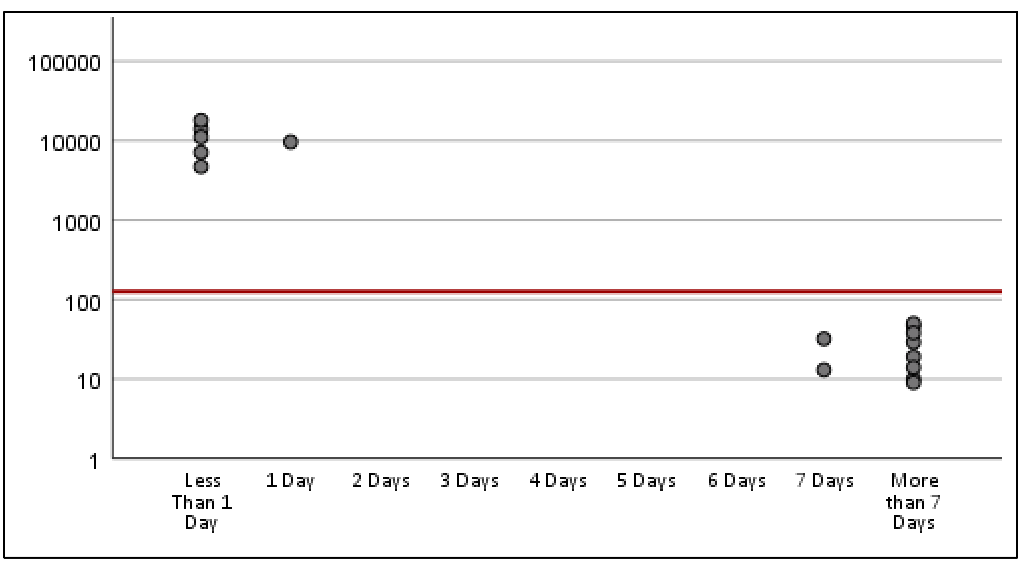
(B)
Lampasas River
at Lampasas CR 2925
Station 15770



(C)
Lampasas River
at FM 2313
Station 16404



(D)
Lampasas River
at US 190
Station 11897



(E)
Lampasas River
at HWY 195
Station 11896

Figure 14A-E Log of E. coli plotted against DSLP for each sample on the mainstem of the Lampasas River.

Major Tributary Stations

18782: Sulphur Creek at Naruna Road

The Sulphur Creek at Naruna Rd monitoring station (station 18782, **Error! Reference source not found.** and **Error! Reference source not found.**) is located in southern Lampasas County. This station is upstream from the city of Lampasas, although the upstream drainage area is primarily rangeland. The drainage above this station is 81 square miles.

15781: Sulphur Creek at CR 3010

The Sulphur Creek at Lampasas County Rd 3010 monitoring station (station 15781, Figure 18 and Figure 19) is located in southern Lampasas County, several miles east of the city of Lampasas. This station is down stream from station 18782 and has a drainage area of 107 square miles.

15250: Sulphur Creek at CR 3050

The Sulphur Creek at CR 3050 monitoring station (station 15250, Figure 20 and Figure 21) is located in southern Lampasas County, approximately 1.5 miles upstream from Sulphur Creek's confluence with the Lampasas River. This station the most downstream site on Sulphur Creek and has a drainage area of 130 square miles.

21016: Clear Creek at Oakalla Road

The Clear Creek at Oakalla Road monitoring station (station 21016, Figure 22 and Figure 23) is located in eastern Burnet County, approximately 0.5 miles upstream from its confluence with the Lampasas River. Clear Creek originates in southwestern area of the city of Copperas Cove and is partially residential/urban and partially rangeland land use. The drainage area for this station is 30 square miles.

18759: Reese Creek near FM 2670

The Reese Creek near FM 2670 monitoring station (station 18759, Figure 24 and Figure 25) is located in western Bell County, approximately 0.4 mile upstream from its confluence with the Lampasas River. Reese Creek originates in southwestern area of the city of Killeen and is partially residential/urban and partially rangeland land use. The drainage area for this station is 29 square miles.


Figure 16 Station 18782, Sulphur Creek at Naruna Road, looking upstream from sampling location on November 10, 2020.


Figure 17 Station 18782, Sulphur Creek at Naruna Road, looking downstream from sampling location on November 20, 2020.

Figure 18 Station 15781, Sulphur Creek at Lampasas CR 3010, looking upstream from sampling location on October 13, 2020.

Figure 19 Station 15781, Sulphur Creek at Lampasas CR 3010, looking downstream from sampling location on October 13, 2020.

Figure 20 Station 15250, Sulphur Creek at CR 3050, looking upstream from sampling location on October 13, 2020.


Figure 21 Station 15250, Sulphur Creek at CR 3050, looking downstream from sampling location on October 13, 2020.


Figure 22 Station 21016 Clear Creek at Oakalla Road, looking upstream from sampling location on October 13, 2020.

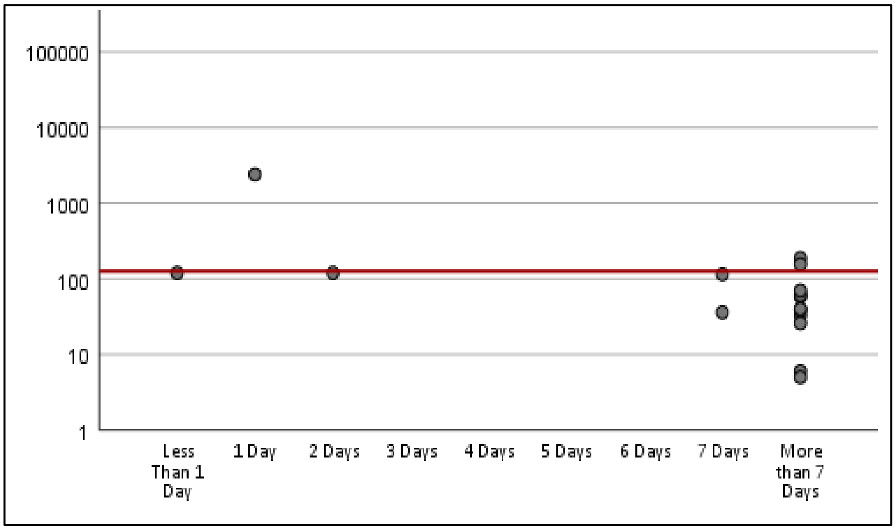
Figure 23 Station 21016 Clear Creek at Oakalla Road, looking downstream from sampling location on October 13, 2020.

Figure 24 Station 18759, Reese Creek at FM 2670, looking upstream from sampling location on October 13, 2020.

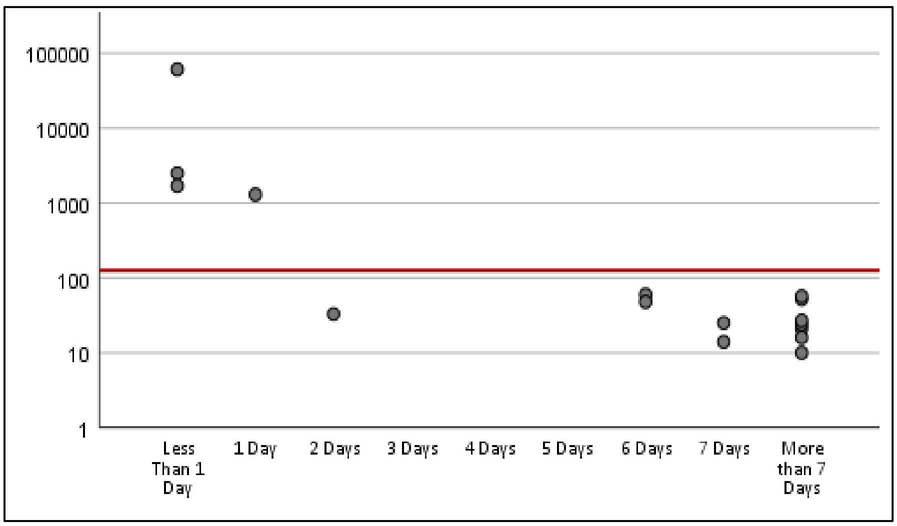
Figure 25 Station 18759, Reese Creek at FM 2670, looking downstream from sampling location on October 13, 2020.

Analysis of Major Tributary Stations Data for Trends

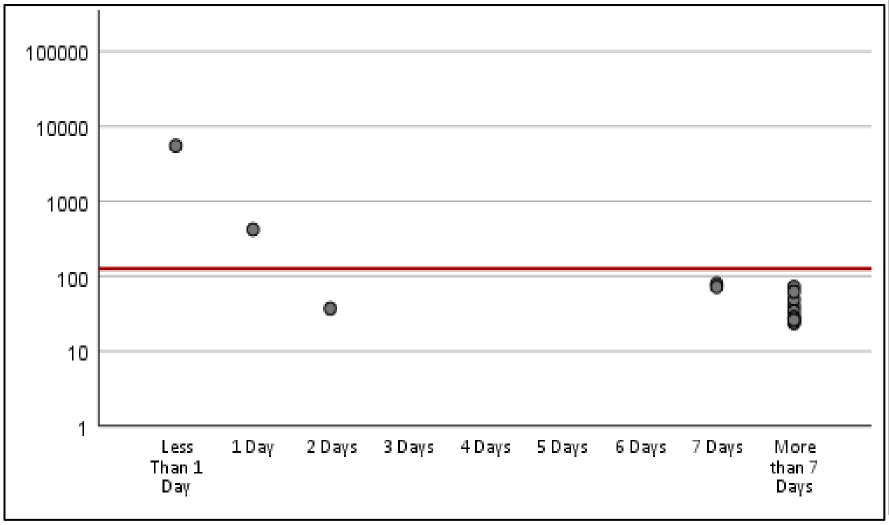
Again, a 13-month data period is not temporally robust enough for significant statistical tests, but it is interesting to look at the relationship between E. *coli* and the Days Since Last Precipitation (DSLP) parameters. The following Figure 26 (A-E) illustrates the (log of) E. *coli* samples collected plotted on the X axis against the number of days since last precipitation on the Y axis. The red line illustrates the state standard of 126 cfu/100mL). Those stations on Sulphur Creek, the only station with sampling points above 126 cfu/100mL is the most upstream station, 18782. As you move downstream, there are no samples that exceed 126 cfu/100mL during drier periods (more than 7 days since last precipitation). Additionally, when looking at the stations on Clear Creek and Reese Creek, only Clear Creek has sampling points above the state standard during the drier periods.



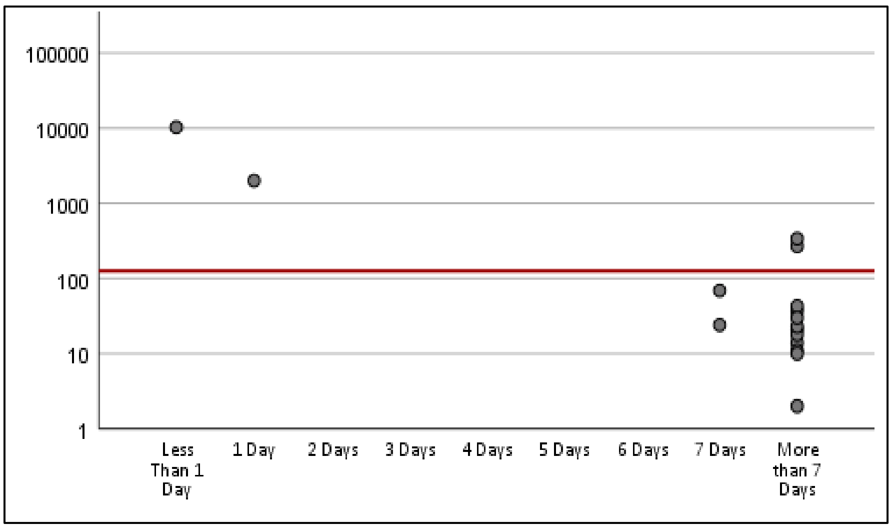
(A)
Sulphur Creek
at Naruna Rd
Station 18782



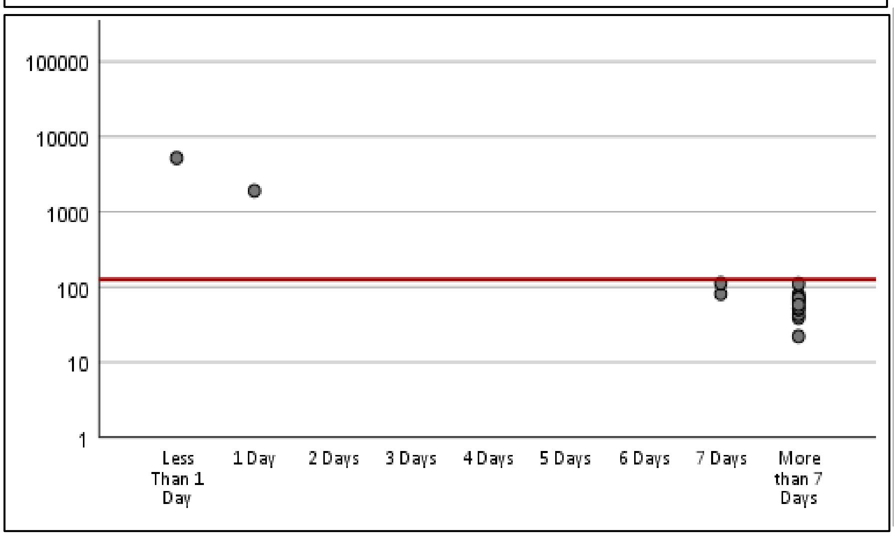
(C)
Sulphur Creek
at CR 3050
Station 15250



(B)
Sulphur Creek
at CR 3010
Station 15781



(D)
Clear Creek
at Oakalla Rd
Station 21016



(E)
Reese Creek
at FM 2670
Station 18759

Figure 26A -E Log of E. coli plotted against DSLP for each sample on the major tributaries of the Lampasas River.

Analysis of 24 HR DO Sampling

As mentioned in the project overview, the collection of five 24-Hr DO samples at North Fork Rocky Creek (station 18334, Figure 27) was included in this project. North Fork Rocky Creek was a part of a special study conducted by TCEQ in 2009. TCEQ evaluated sources of oxygen-demanding materials and their impacts on dissolved oxygen in the creek. In addition to the collection of 24-hour dissolved oxygen data over a two-year period between August 2002 and September 2004, biological data was also collected. Data indicated that it supports a relatively healthy biological community, better than that which would be expected based on the results of the dissolved oxygen monitoring. In 2010, the TCEQ adopted revised, site-specific standards for dissolved oxygen in Rocky Creek.

Figure 27 Station 18334, North Fork Rocky Creek at FM 963 on August 11, 2020.

Although the standards were adopted (Figure 28), no additional data had been collected within the segment to be used in assessment until the previous Lampasas SWQM project (TSSWCB #16-06). Project partners were able to reallocate funds that had been earmarked for biased flow samples to allow collection of 24-Hr DO samples to be used in future assessments. This project collected an additional 5 samples to be used in future assessments. Table 6 is a summary of the sample events collected during both projects; samples highlighted in blue were collected in this project.

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Chapter 307 - Texas Surface Water Quality Standards
Rule Project No. 2016-002-307-OW

SEGMENT	COUNTY	WATER BODY	ALU	DO	DESCRIPTION	ADDITIONAL SITE-SPECIFIC FACTORS
1217	Burnet	North Fork Rocky Creek	I	4.0	Intermittent stream with perennial pools from the confluence with South Rocky Creek upstream to its headwaters approximately 11 km west of US 183	A 24-hour average DO criterion of 2.0 mg/L and a 24-hour minimum DO criterion of 1.0 mg/L apply when stream flows are below 1.5 cfs.

Figure 28 TCEQ's site specific standards for North Fork Rocky Creek.

Station 18334		Flow	Dissolved Oxygen			Specific Conductance			Temp			pH	
Deployment	Retrieval		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
10/10/2018	10/11/2018	0.01	0.4	3.2	1.4	516	530	522	19.2	21.9	20.6	7.5	7.5
01/08/2019	01/09/2019	36	9.6	10.3	9.8	595	611	606	12.5	14.6	13.5	8.2	8.2
03/18/2019	03/19/2019	12.3	8.5	10.7	9.3	598	605	602	14.4	18.3	16.0	8.0	8.1
05/16/2019	05/17/2019	19.7	7.5	8.4	7.8	563	570	566	21.4	24.8	22.7	8.1	8.2
07/09/2019	07/10/2019	2.7	4.5	7.6	5.7	544	566	557	26.5	30.4	28.1	7.7	7.9
11/19/2019	11/20/2019	19.7	7.47	8.4	7.8	563	570	566	21.4	24.8	22.7	8.1	8.2
01/14/2020	01/15/2020	0.1	3.5	7.5	4	635	644	640	13.9	15.6	14.9	7.4	7.5
4/13/2020	4/14/2020	4.7	7.6	8.0	8.1	403	464	435	15.3	20.4	17.5	7.8	8.0
07/14/2020	07/15/2020	<0.1	1.9	7.5	4.4	590	603	598	27.7	30.0	28.9	7.3	7.5
09/15/2020	09/16/2020	<0.1	3.0	7.5	7.0	607	622	614	23.4	24.6	24.1	7.3	7.5
Average			5.4	7.9	6.5	561.4	578.4	570.6	19.6	22.5	20.9	7.7	7.9

Table 6 Summary of 24-Hr DO sampling on North Fork Rocky Creek (station 18334).

Conclusion

Although a 13-month sampling period should not be measured against itself for statistical analysis, it will be extremely useful in measuring trends over the longer-term surface water quality monitoring of the Lampasas River watershed. This data will be used in the measurement of trends in addition to data collected through TSSWCB project 16-06, 13-09 and 10-51.

In summary, TSSWCB Project 19-54 has been completed and was essential to the continued water quality monitoring for the Lampasas River WPP. Early water quality data was presented to stakeholders. Results will be communicated during the next Partnership meeting. While implementation of WQMPs did not start until mid-2015, and remediation of failing septic systems began in 2020, this water quality dataset builds upon the existing foundation for a robust dataset to monitor trends and changes in water quality as implementation moves forward.

TSSWCB project 20-11, *Continuation of Surface Water Quality Monitoring to Support the Implementation of the Lampasas River Watershed Protection Plan*, will begin collecting samples in mid-2021, upon QAPP approval and will provide 24 additional months of routine sampling and 8 quarterly biased flow sampling events at the same 10 sites.